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MEETING PLACE

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NEW DISCOVERIES POSE NEW QUESTIONS ABOUT:

1. A PREHISTORIC ONTARIO GRIZZLY

2. THE MOON

3. BURIED CITIES OF KURDISTAN

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THE LAKE SIMCOE GRIZZLY

Curiosity and luck played a part in discovering Ontario's first grizzly—nearly 12,000 years after its death

R. L. Peterson, Curator of Mammalogy

The Royal Ontario Museum recently announced the discovery of a remarkably well preserved skull of grizzly-type bear that died 11,700±250 years ago. This discovery is highly significant from several points of view. Specifically, it appears to be the first valid record of a grizzly bear ever found east of the Great Lakes, either modern or prehistoric in origin. There have been persistent rumours of such an animal in the Ungava region of northern Quebec, but no specimen or portion of a specimen is known to exist, and the nearest known occurrence of the grizzly within historical times is some 1,000 miles to the west, in Minnesota, during the early days of exploration. Fossil specimens from the Pleistocene have been found no nearer, and none is so well preserved. A large bear of grizzly size has, however, been suspected in the interglacial deposits of the eastern Great Lakes region on the basis of postcranial fragments. The new specimen should shed much light on the relationships between earlier fossil bears and the modern species of both Europe and Asia as well as North America.

More generally, we have only meagre knowledge of any mammal fauna from the interglacial and late glacial periods in the Great Lakes region. No large and well-known deposits have been discovered and most specimens consist of isolated fragments recovered from old bog sites or gravel deposits. Since the entire Great Lakes region was once completely covered by glaciers, these remains must have been subjected to immense grinding action with the spread of the ice fields and their subsequent melting and deposition of glacial till. The chances of a specimen remaining intact during such a disturbance are indeed small, and the chances of discovering such specimens are smaller still. This near-complete skull (the most important part of any mammal for study) is therefore of particularly great interest from the zoological viewpoint.

Moreover, it is of interest to both historical and glacial geologists because it provides a fixed date for the time that the local gravel deposit was formed, which in turn will allow other correlations to be made. The site, close to

Orillia, is associated with beach sand and gravel deposits near the old shore of Lake Algonquin—a giant prehistoric body of water which with the retreat of the glaciers covered most of the area of the present Upper Lakes and spread eastward beyond Lake Simcoe. Recent studies suggest that an outlet opened near North Bay some 10,000 to 11,000 years ago which drained the lake through the Trent Valley, and may have had some effect on the preservation of our specimen.

Finally, the discovery is a striking lesson in the part that good luck and human curiosity play in the advance of knowledge. It began ordinarily enough with the delivery of a load of gravel to a new home being built in Orillia. While the load was being shovelled into the basement, a skull and some smaller bones (a cervical vertebra and one lower jaw) were discovered. Mr. Basil Baye, who found them, took them home and inevitably began wondering what kind of animal they came from. Finally the local Conservation Officer, J. T. Ross, was called in, and delivered the bones to the Southern Research Station of the Ontario Department of Lands and Forests at Maple.

On December 10 I received a phone call from Mr. Robin Hepburn, biologist at the station. He said that he and other members of the staff had examined an interesting specimen which they wished to submit to the ROM for identification. They had agreed it was neither a black bear nor a polar bear, and suspected it was a grizzly. When the specimen reached the Department of Mammalogy, a quick comparison with examples of modern grizzly bears from western Canada and Alaska showed that it was indeed closely related to them but differed in some detail from them all.

This was not surprising. The group comprising the grizzly and big brown bears of the New World is a highly variable and complex one with no fewer than 87 different Recent Era forms described and named. Quite obviously the early mammalogists responsible for most of these names were unduly impressed by this great variability in cranial details and failed to recognize differences which reflect sex, age or normal individual random variation, as opposed to characteristics which are genetically fixed in large populations.

Although difficult to define to the satisfaction of all zoologists, a species to most mammalogists is a group of interbreeding animals that are sufficiently

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Cranial measurements, in mm., of this specimen, R.O.M. 35226, are as follows: Condylobasal length, 322; zygomatic breadth, approximately 302; mastoid breadth, 136.6; length of palate, 164; canine-molar length of maxillary tooth row, 128; length of last three upper cheek teeth (P^4-M^2), 75.8; greatest width of palate including last molars (M^2), 87.8; width across upper canines, 70.2; height of occiput, 96.7; least interorbital breadth, 76.5; width across postorbital processes, 110.6; greatest length of mandible, 320; canine-molar length of mandibular toothrow, 145.3; length of last four lower cheek teeth (P_3-M_2), 82.8; width across lower canines, 61.7. The dentition is complete except for the incisors and the anterior or first premolars, both above and below.

distinct from all other kinds to be genetically isolated. In other words they "breed true" and do not normally breed with other species under natural conditions, but when crossed under artificial conditions usually produce infertile offspring, if any. In some species, particularly wide-ranging ones, there may be a tendency for some populations to become isolated from adjoining ones; in such cases certain distinctive genetic characteristics may become fixed and spread throughout the population. Usually they are of a minor nature involving such aspects as colour, size, proportions, or cranial details. When a species exhibits consistent morphological differences in one part of its range from others, the species is divided into subspecies (also called geographic races). The grizzly bear is particularly susceptible to such geographic variation in view of its range—which runs from north central Mexico through the Rocky Mountain region of the United States and Canada, up to the Arctic tundra of western Canada and most of Alaska. Its great variability has resulted in a confusion of species and subspecies. Recently mammalogists have swung to the opposite extreme, and would consider all grizzly, Alaskan big brown and Old World brown bears as representing only one species, *Ursus arctos*, with many geographic races. Whatever the name, the great variability in bears made it that much harder to pinpoint our discovery.

The ROM has no specimens of the old world brown bear, but a check of published photographs and measurements suggested that our specimen might actually be closer to it than to the western grizzlies. We immediately had to consider the possibility that the Orillia bear was a circus or zoo animal which had been buried where it was found. Experience, however, has shown that specimens which have lived for a long time in a zoo can be distinguished by dental abnormalities caused by their diet: the teeth of this specimen appear perfectly normal in all respects. We had been told that the skull came from a gravel pit. The specimen was in such excellent condition it appeared fantastic that it could be as old as the site suggested—in other words, that it had died here normally when the gravel deposit was being laid down. We were faced with two possibilities. Either the skeleton was a recent intrusion as a result of some action by man, or we had the kind of discovery museum people dream about but rarely find.

At our request Conservation Officer Harold Van Wyck searched the spot where the gravel had been dumped from the truck, and found the missing lower jaw and a portion of leg bone. On December 14 my assistant, Mr. John B. Heppes, also visited the building site with Mr. Van Wyck, and then went on to the gravel pit from which the load had been taken. And here we met a stroke of incredibly good fortune. The specimen had come from the very last load of gravel on the last day of operations for the season. None of the surrounding deposit had been touched. The ground was now frozen, but the pit owner, Mr. J. Ennis, agreed to let us check the site

carefully for further bones as soon as spring arrived, and to withhold any digging in that area until we were finished.

We reviewed the evidence. The specimen had the appearance of a normal wild animal; it was about average size for a grizzly and was about middle age at time of death; it was so well preserved and the skull so complete that it seemed almost unbelievable that it could have been dead for more than a few years. Yet it had been taken from a site approximately 30 feet below the surrounding grade, in a part of the landscape buried when the glaciers retreated 10 to 12 thousand years ago.

About 20 years ago Dr. Willard Libby pioneered a technique which has made it possible to establish the age of plant and animal material which has remained buried for a protracted period. The method is based on the radioactive decay of natural radiocarbon (Carbon14). Radioactive Carbon14 is constantly being produced in the upper atmosphere by cosmic ray reactions, and in turn is oxidized and mixes with the inert normal carbon dioxide in the life cycle. Because the mixing time is relatively short, an equilibrium concentration of Carbon14 is maintained in the atmosphere, land, water and life (both animal and plant) of the earth. When an animal or plant dies, however, and is removed from the equilibrium cycle, its C14 content decays with a half-life of 5500 years. A precise measurement of the remaining C14 content of a bone makes it possible to calculate the time elaped since the animal died within relatively fine limits. Two methods of radiocarbon dating of bone have been devised. The first, most commonly used in the past, consists of carrying out a carbonate fraction of the bone tissue, removing the carbonate by evolution of carbon dioxide with acid. The second technique is based upon the collagen (bone protein) content. The collagen is recovered by a slow digestion of bone in cold dilute hydrochloric acid with subsequent filtering to recover the insoluble collagen, which in turn is dried and then burned and dated. The collagen content of bone has been shown to vary with time from about 25 per cent in modern specimens to about one or two per cent at 10,000 years.

In the case of our grizzly, it seemed worth the gamble to sacrifice a portion of one of the limb bones on a Carbon14 test. Certain commercial laboratories were prepared to run the tests for between $150 and $200. Our departmental budget had been exhausted by the costs of field work in British Honduras, but special funds were made available. Then began the long wait, with all the anxiety of an expectant father. The report arrived on April 1. Had we in fact made fools of ourselves? No, the results were all we had hoped for −11,700±250 years (9750 B.C.)!

Sitting in my office as I tore open the letter was Mr. William Toye, editor in the Canadian office of Oxford University Press. We had just been going over last-minute details on the manuscript of my forthcoming book, *The*

Mammals of Eastern Canada. In it I had reviewed all we knew about bears in eastern Canada, but now this would have to be revised in proof in the light of our new discovery. My mind flashed back to an earlier book in which I had published in considerable detail a theory on the postglacial dispersal of moose (*North American Moose,* University of Toronto Press, 1955). Then I recalled one of my first scientific papers, a comparison of the Recent and Pleistocene fauna of an area in Texas based on work done before World War II. One of my more recent papers was "Changes in the Mammalian Fauna of Ontario": we had known nothing of the occurrence of grizzly bears when that work was carried on. Here was an opportunity to return to a subject in which I have had a long and deep interest.

At the same time, I had to finish two manuscripts which were on my desk. They dealt with something far divorced from sub-fossil bears—tropical bats. One I had just recalled from the printer in order to include some vital data which had been located after it was submitted. They represented another field of considerable excitement: the discovery and naming of two new genera of bats, one from South America and the other from Africa, and an up-to-date revision of two other genera which shed much new light on their status and taxonomic position. These had to be sent to the printer without delay, but first a brief scientific announcement of the Lake Simcoe grizzly was prepared for the appropriate scientific journal.

Where do we go from here? After the initial brief flurry of excitement we are now faced with a long period of hard work and careful analysis. As soon as the gravel pit thawed, we began excavating in a search for more of this important specimen. Our geological colleagues have promised their co-operation in making a careful stratigraphic study of the site to shed as much light as possible on a geological correlation of developing events. Then begins the enormous task of analyzing the specimen in minute detail and then comparing it with at least 87 different named modern bears on the one hand and with all known related species of fossil bears on the other. This will involve trips to the major museums of the world where pertinent material is available. The project requires time and money, two commodities in short supply. We are already too late to apply this year for the usual research grants from agencies that might support this type of work. Unfortunately Canada has very limited sources of research funds and we shall be obliged to carry on with a shoestring operation, using ingenuity to accomplish what must be done.

There are many exciting and challenging questions to be answered. Does the specimen represent an entirely new species, hitherto unknown, or is it closely related to any known fossil species? What are its relationships to modern grizzly bears? Was it more closely related to its nearest modern relation, the plains grizzly, *Ursus horribilis,* or will it prove to be closer to a Barren Land grizzly? Does it show a direct relationship with the European

brown bear? Was there ever really a modern grizzly bear in the Ungava region of Quebec? If so, could it be a descendant of our Lake Simcoe bear? What species were present in the fauna 10 to 12 thousand years ago? What did this large carnivore live on? Did it prey on muskoxen such as *Symbos cavifrons* and *Boothenium sargenti* which are known to have occurred about the same time in what is now southern Michigan? What can we deduce about the ecology of the region at that time? Was the extinct eastern Wapiti contemporary with this grizzly? Why has there been no trace of moose found for the period? Did *Cervalus* (an extinct moose-like animal) survive until this time? What caused the eventual extinction or extirpation of this bear in southern Ontario? How closely did it follow the retreating front of the glacial ice cap? How did this specimen happen to be preserved in such an excellent condition?

These are but a few of the questions for which we seek answers. We are doomed to be caught up in a pyramiding situation for as soon as we discover the answer to any of them we merely expose several other avenues to be explored. This is the story of our life—waiting within my department, as in every other in the ROM, are exciting problems, opportunities and challenges that would take more than ten lifetimes to complete even if we had adequate funds and many more hands to assist with the task. We have learned to live with this frustration and would not change positions with anyone.

NEW LIGHT ON THE MOON[1]

Some current theories about our nearest neighbour —which may have a surface of "floating dust"

PETER M. MILLMAN, National Research Council, Ottawa

On November 5, 1938, I gave a lecture here in Convocation Hall entitled "We Visit the Moon", and at that time I stated that I had every expectation of seeing man make contact with our satellite. The intervening 26 years have more than fulfilled that expectation as already ships from earth have circled the moon, televised it from less than a mile above its surface, and hard-landed on a number of different occasions. Serious plans for manned exploration

[1]Summary of a lecture delivered at the Royal Ontario Museum on February 25, 1965. Dr. Millman is Head, Upper Atmosphere Research, Radio and Electrical Engineering Division, National Research Council of Canada.

of the lunar surface are well advanced in both the Soviet Union and the United States. On the basis of the current progress in space technology, there seems to be no reason why such an attempt should not prove successful.

Since the commencement of the space program in 1957, astronomical research on the solar system has been revitalized and new knowledge in this field is being acquired at an unprecedented rate. For this reason much of what can be said today may already be out of date tomorrow. However, I will do my best to summarize our present view of the physical nature of the moon, with particular emphasis on the detailed structure of its surface.

As we discuss the lunar surface features, certain basic facts about our natural satellite should be borne in mind. It is a small world with a diameter of 2160 miles, roughly one-quarter the diameter of the earth. Its surface gravity is only one-sixth that of earth, which results in a velocity of escape barely 1.5 miles per second. Absence of any appreciable atmosphere leads to tremendous temperature extremes at the surface, from over +210° F. when the sun is in the zenith to −250° F. on the night side. The lack of atmosphere also means that we find little surface erosion or weathering, and large visible features remain essentially the same for thousands or millions of years.

The biggest and most prominent surface markings, easily visible to the unaided eye, are dark areas, traditionally named seas or maria. These cover approximately 40 per cent of the lunar hemisphere which faces us, and are found to be, on the average, two miles lower than the bright upland regions surrounding them. Use of even the most modest telescope reveals the bright uplands as very mountainous, with a tendency for large curved mountain ranges to lie along the borders of the more prominent seas. But the most striking characteristic of the surface is the large number of roughly circular markings of all sizes, from giants several hundred miles across down to the smallest visible in earth-based telescopes, about half a mile in diameter. These are the lunar craters, and in recent months photographs taken by U.S. spacecraft Rangers VII and VIII [and, since this lecture was given, by Ranger IX on March 24, 1965] have extended the series down to craters one foot in diameter.

The number of craters increases as the size decreases. For example, on the hemisphere of the moon facing us, there are some 20 craters with diameters greater than 130 miles, 1700 larger than 16 miles, and about 200 times this number larger than one mile across. If N is the cumulative count of craters larger than a given diameter D, there is a straight-line relation between log N and log D. Baldwin (1964) has shown that this straight line, extended down to the smallest craters visible from earth, lies well above the observed numbers at the lower end. In other words there are too few craters smaller than two miles in diameter to satisfy the size-distribution law found for craters larger than two miles across.

Baldwin (1962) has also made a detailed study of the relation between diameter and depth for both terrestrial explosion craters and lunar craters of all sizes. Plotting log D against log d (d is crater depth), Baldwin found a smooth curve for explosion craters ranging from 1 to 1000 feet in diameter, for a given value of the scaled depth of the explosive charge. This curve, when extended, fitted the large lunar craters and the terrestrial meteorite craters. More recently Baldwin (1965) has also shown that the small lunar craters measured on the Ranger VII photographs fit the terrestrial diameter-depth relation even more exactly than do the large lunar craters. The evidence for a large number of the craters on the moon being impact craters is thus very strong. These must be both primary impact craters and secondary impact craters, but no simple way has yet been found to separate the two types. Photographs of the Ranger series have high-lighted the fact that several other kinds of craters also exist on the moon.

Up to the present we have been discussing detail on the moon which can be seen and measured. Most of this evidence is on a scale of miles, or large fractions of miles. To obtain information on a scale of inches or a few feet, we can use radio waves bounced off the moon. To the eye the moon reflects visible light fairly well from both the centre of the disk and from the limb. But when viewed in radio wavelengths of from one to several hundred inches, it is found that most of the reflection comes from a small area near the centre of the disk, while the limb reflects little of the incident energy. This means that on a scale of two or three feet the moon appears essentially smooth. Only some five per cent of its surface is rough, while the remainder consists of smooth areas with random slopes inclined between five and eight degrees to the horizontal (Evans and Pettengill, 1963).

Infrared observations made during recent lunar eclipses have added interesting information. When the moon enters the earth's shadow, sunlight is cut off suddenly from the lunar surface. Though most of the surface cools rapidly, suggesting an insulating cover like dust or porous material, certain spots, several hundred in number, retain the solar heat and remain much warmer than the surroundings. The crater Tycho is one of the most outstanding examples, as the temperature of the material here during an eclipse is 70° to 80° F. warmer than the surrounding area (Sinton, 1962). Possibly there is more exposed rock or a thinner dust layer in this region of the moon.

Tycho, 52 miles in diameter, is unique in other ways. For example, its radio reflection doesn't match that of the rest of the moon. While Tycho doesn't look very different from the other craters near it at first or last quarter, at full moon Tycho is easily the most prominent single feature we see. At this phase it looks like a bright shining ring, and from it radiate series of straight white rays, some extending for over a thousand miles. These give

the moon somewhat the appearance of an exotic fruit with the stem at the position of Tycho.

The average shade of the moon's surface is dark as it reflects only seven per cent of the light falling on it. The general colour value is reddish and this hue seems to be consistent over the entire surface, suggesting that it is a property of the texture rather than the type of material. Superimposed on this basic reddish tone are small colour differences indicating a variation from one location to another in the type of rocks or dust. These quantitative colour studies result from the photometry of photographs taken with a number of narrow-band colour filters. Maps of the moon are now being constructed similar to the brightly coloured maps of the earth we study in geology. The only difference is that we don't yet know the nature or the chemical composition of the different types of surface indicated on these lunar maps.

One of the most important sources of information about the detailed structure of the lunar surface is a study of the variations in moonlight with changes in the angle at the moon between the sun and the earth. This angle is called the phase angle, and ranges from close to zero at full moon to nearly 180 degrees at new moon. Most reflected light is polarized to some extent and the light of the moon is no exception. We can draw curves showing the percentage polarization for various parts of the moon at different phase angles. This type of study was initiated by Lyot in 1929, and the method has been considerably amplified and refined more recently (Dollfus, 1961; Wright, Wright and Wright, 1963). For terrestrial materials the curve of polarization versus phase angle shows marked differences for surfaces with various textures and compositions. For the lunar uplands this polarization curve fits best the laboratory curve found for a grey-brown granite sand with an average grain size 0.01 inch. The curve for the lunar maria fits a basalt sand with a somewhat smaller grain size. One must be careful to use this polarization data only in conjunction with evidence from other methods of investigation.

A striking physical effect found on the moon is the variation in the total amount of visible light reflected as the phase angle changes. Strangely enough the tilt of the moon's surface to the line of sight doesn't seem to matter very much but the phase angle certainly does. The reflected light increases fairly uniformly, as the phase angle decreases from more than 30° down to 5°. For smaller phase angles than 5° the increase in reflected light becomes more and more rapid. Putting it in another way, the moon is a much more efficient reflector when the reflected light moves back along nearly the same path as the incident light. Since this effect is more or less general for the whole of the moon it would seem to be, like the reddening, a property of texture rather than of material and composition.

A surface structure consisting of nearly vertical projections, closely spaced,

would exhibit small-scale shadows, except where the illuminating source and the viewer are nearly in the same line, and would thus duplicate in some measure the effects we see on the moon. The formulation of various lunar-surface models to explain the observed reflecting properties has led to the use of some rather intriguing descriptive terms, such as "fairy castles" and "moose moss". One of the most recent quantitative studies of the problem was carried out by Gehrels, Coffeen and Owings (1964), who show that the reddening, and both the polarization and the reflection phase effects, can be explained by assuming a thin layer of dust particles suspended above the lunar surface by electrostatic repulsion forces, a "floating dust" model one could say. To duplicate closely the observations the layer would have to be just under 0.002 inch thick, and consist of particles 0.0001- to 0.0002-inch diameter spaced by 0.0003 inch. It is calculated that the moon could accumulate such a layer from interplanetary space in 10,000,000 years.

In summary then, we find the surface of the moon rough on a scale of miles or many feet, relatively smooth on a scale of a few feet or inches, and rough on a scale of thousandths of inches and smaller.

In this very brief survey we have had to omit the mention of many significant facts and theories relating to the moon. And we have neglected almost entirely the very interesting field of speculation concerning the origin of the moon and its surface features. It is now almost universally agreed that the ray-craters like Tycho originated from impact events and, if this is true, there must be millions of tiny secondary impact craters on the moon. There would also seem to be new photographic evidence for localized volcanic activity, and small crater chains along vents or clefts.

It seems quite likely that the lunar surface may be fairly porous to some depth, but the idea of a deep layer of loose dust is currently out of favour, particularly after considering the evidence of the Ranger photographs. Under the vacuum conditions found on the moon the dust falling from space would not behave as dust does in our atmosphere at the earth's surface. On the moon it would probably become welded to the surface by molecular attraction, except where the size and electric charge were suitable for producing the "floating dust" mentioned earlier. One of the biggest unanswered questions concerns the strength of the surface crust on the moon, but reliable information on this point will probably be unavailable until after the first soft-landing of a Surveyor spacecraft. However, this may be expected in the reasonably near future.

REFERENCES

BALDWIN, R. B., 1963
The Measure of the Moon, University of Chicago Press.
—— 1964
Astron. J. vol. 69, p. 377.

—— 1965
Private communication.
DOLLFUS, A., 1961
Physics and Astronomy of the Moon, p. 131, edited by Kopal, Academic Press, N.Y.
EVANS, J. V. and PETTENGILL, G. H., 1963
The Moon, Meteorites and Comets, p. 129, edited by Middlehurst and Kuiper, University of Chicago Press
GEHRELS, T., COFFEEN, T. and OWINGS, D., 1964
Astron. J. vol. 69, p. 826.
LYOT, B., 1929
Ann. Obs. Paris, vol. 8, p. 1.
SINTON, W. M., 1962
The Moon, p. 469, edited by Kopal and Mikhailov, Academic Press, N.Y.
WRIGHT, F. E., WRIGHT, F. H. and WRIGHT, H., 1963
The Moon, Meteorites and Comets, p. 1, edited by Middlehurst and Kuiper, University of Chicago Press.

NEXT STEP FROM HASANLU

Why an ROM *archaeologist is scouring Kurdistan for traces of buried grey pottery*

T. CUYLER YOUNG, Jr., Assistant Curator, Near Eastern Department

High in the Zagros mountains forming the western edge of the greater Iranian Plateau, where on a modern political map the borders of Iran, Iraq and Turkey meet, lies the green and fertile valley of Solduz. Since 1957 archaeological excavations have been under way in the valley under the joint sponsorship of the University Museum, Philadelphia, the Metropolitan Museum of Art of New York City and the Archaeological Service of Iran. In the summer of 1964 the Royal Ontario Museum, assisted by a grant from the office of the President of the University of Toronto, joined this project in the field, and the Museum's flag was unfurled in yet another corner of the world.

Excavations in Solduz have so far uncovered an almost continuous record of man's history beginning around the middle of the sixth millennium B.C. and stretching into the early centuries of the Christian era. At the small mound of Hajji Firuz were found houses, tools, pottery and burials of a Neo-

lithic culture dating to 5500 B.C. and representing one of the earliest agricultural groups on the Iranian plateau. Another site in the valley, Dalma Tepe, has yielded evidence of a heretofore unknown and remarkable painted pottery culture of the fifth millennium B.C. The principal effort of the expedition has, however, been directed at the large site of Hasanlu Tepe, where successive seasons of work have uncovered extensive remains of an early first millennium B.C. citadel and town.

The mound of Hasanlu is shaped somewhat like a bowler hat. The brim of the hat is represented by a large Outer Town which covers a circular area approximately two-fifths of a mile in diameter and rises about twenty-seven feet above the valley floor. The crown of the hat is the Citadel mound, rising in the centre of the Outer Town to a height of ninety feet above the plain. On the Outer Town Flats were the houses and workshops of the common people. Inside the Citadel, protected by a fortification wall with stone foundations ten feet thick, were the palaces and religious buildings which mark the site as the seat of a local dynasty which controlled at least the whole of the surrounding valley. The fortification wall of the Citadel and the foundations of its important buildings were laid sometime around 1000 B.C., and the entire town was captured and burned in a military attack about 800 B.C. This sacking of the city was a major catastrophe for the ancient inhabitants of Hasanlu, but the modern archaeologist can only thank the unknown invader who breached the wall and lit the fires that destroyed the town in a matter of hours. Beneath the fallen mud roofs and upper stories of the Citadel buildings remains of ancient man have lain preserved and untouched for almost three thousand years.

If one enters the Citadel from the west through the ancient breach in the fortification wall which marks the site of the original gate, one sees on the right hand a small palace and, further on, a much larger building called by the excavators "Burned Building II", laid out on much the same plan as the palace but clearly functioning as a temple. This, the most important and impressive structure cleared within the Citadel, consists of a large columned hall fronted by two long narrow rooms which run across the full width of the building. Down both sides of the great hall are separate storage and work rooms from which many important objects were recovered. The columned hall, whose roof was supported by a double row of six wooden columns set on stone and mud plaster bases, was the focal point of the ceremonies for which the whole structure was designed. In the centre of the room, on a large rectangular brick platform, burned a fire either sacred in itself or used for burnt sacrifices. Facing this fire altar, against the rear wall of the hall, is a raised platform of brick off which a narrow door gives access to a small room—an inner sanctum—in which may have stood an image of the god. Mud brick benches providing seats for the important dignitaries who

took part in the ceremonies are on either side of this platform. The size of this hall and the remarkable preservation of the walls, which, because of the firing of the mud brick at the time the city was destroyed remain standing in places to a height of ten feet, combine to make the whole structure a remarkable discovery.

From ancient times to the present day northwestern Iran has been a meeting ground of cultures. In the days when Hasanlu was a flourishing city, cultural stimuli came from several different directions. To the north were the settled and nomadic peoples of the Caucasus who funnelled influences from points as distant as central Asia in the east and the Danube basin in the west into the Hasanlu region. From the east, out of the plateau beyond the Zagros mountains, came peoples and ideas at home in central Asia, Afghanistan and northern India. To the south were other local Zagros cultures and the Elamites, and to the west, a short hundred miles across the mountains, lived the Assyrians, the dominant political, military and cultural force in the Near East at the time. All of these several cultural strains are reflected in both the art and the architecture, to say nothing of the daily life, of the people of Hasanlu.

Burned Building II itself represents a blending of architectural traditions from north Syria and the east. The two long narrow rooms fronting the columned hall are characteristic of the Bit-Halani structures of northern Syria and, at Hasanlu, probably represent a cultural borrowing from the Assyrians. The columned hall itself is of more obscure origins, but is perhaps to be identified with a type of architecture characteristic of Indo-European peoples, and is quite probably a direct architectural ancestor of the columned halls which became such a marked feature of later Achaemenid architecture as we know it from Pasargade and Persepolis.

It is, however, in the hundreds of small objects found at Hasanlu that the richness and variety of its culture are best revealed. The 1964 excavations brought to light a remarkable collection of carved ivories. Most were flat plaques originally used as decoration on the outside of wooden boxes, but figures in the round were also found which were either statue fragments or decorative knobs on furniture. Ivory at its best is a delicate substance, but all of these ivories had been badly burned in the fire which destroyed the citadel, and hence were either already smashed into a thousand pieces or shattered at the slightest touch. Their excavation was a slow and painstaking process. We are faced now with months of work fitting the fragments together before their full story can be known. Enough pieces were, however, recovered whole or almost whole, to reveal a treasure with wide artistic connections. Several of the plaques were clearly of strictly local workmanship, carved by artists who had adapted to their own individual artistic impulses, techniques and styles more common in Assyria. Other examples, particularly

some of the figures in the round, were purely Assyrian in style and were probably imports. Still other items showed strong affinities with ivories carved in north Syria, along the Mediterranean Coast and even as far away as Egypt. Two female heads in particular, perhaps the heads of goddesses, may actually prove to be of Syrian workmanship.

Of the cultural stimuli from the west none was so strong as that of Assyria, for north Mesopotamian or Assyrian influence can be seen in many objects other than the ivories. Decorative terra cotta wall tiles of perhaps a dozen different types have been found at Hasanlu, which, not only in themselves but in the details of their construction, reveal Assyrian influence. Cylinder seals, bracelets, beads, decorated bronze drinking vessels and certain weapon types also testify to Assyria's artistic dominance and are a cultural reflection of the political and military situation of the time, for the 9th century B.C. witnessed an almost continuous effort by the Assyrians to control the dangerous mountain peoples of the western Zagros.

Evidence for cultural influences coming from the north, from in and across the Caucasus mountains, is found principally in certain weapon types and horse trappings. Swords in bronze and iron, many with inlaid bone or wooden handles, and often cast in elaborate and even bizarre shapes, have been found at Hasanlu. Here are close parallels to swords found in the late second and early first millennium tombs of the Caucasus and the Ukraine. Horse bits and harness decorations in bronze also point to relations with peoples more at home further to the north.

It is when we turn to pottery, however, that we discover traces of perhaps the most important of all the foreign influences on the culture of Hasanlu in the first millennium: the influences which came from the east. Characteristic of this period at Hasanlu is a pottery which ranges in colour from light grey to dark black and which occurs in several distinctive shapes, perhaps the most marked of which is a rather squat pitcher with a single handle and a rather long pouring spout. This ware of Hasanlu would appear to have its origins in a late third and early second millennium grey ware which is found in central and northeastern Iran. The gradual movement westwards of this taste for grey pottery can be traced at several sites in western Iran, where its introduction represents a complete break in the ceramic sequence native to the west. Thus there is evidence in this pottery for the gradual migration into western Iran of a new group of people. It would also seem that this same grey ware of early first millennium Hasanlu is the direct ceramic ancestor of the pottery used by the Achaemenids in the latter half of the same millennium. Thus Hasanlu gives us one important link in a ceramic chain connecting prehistoric eastern and northeastern Iran with historic south and northwestern Iran at the time of the first Iranian empire.

It has long been known that the Iranians are not native to the plateau and country which bears their name today and has been theirs since roughly the seventh century B.C. Yet it is not clear just where the Iranians came from or when they entered Iran. Here, in this grey ware pottery of Hasanlu, we may have an important archaeological clue to the solution of this tantalizing historical mystery. The people who came from the east, who brought the grey ware to Hasanlu and northwestern Iran, may turn out to be the Iranians.

This tentative suggestion carries this report from the past into the present and raises the important question, "Where do we go from here?" The Museum's Near Eastern collection has been enriched by our share of the many finds from Hasanlu, and several important archaeological and historical questions have been answered by this excavation. Yet any archaeological expedition poses more questions than it answers. In this it does not differ from most other types of research. As work at Hasanlu draws to a close, where do we turn now to seek answers to some of the more important questions raised by our work at Hasanlu? Specifically, where should the ROM and the University of Toronto probe next in an effort to follow up their contribution to Hasanlu?

The first step will be to conduct an exhaustive search of those areas in western Iran likely to yield a site whose excavation will throw more light on both the origins and the later development of the grey ware pottery of Hasanlu, particularly a site that will have a more complete record of the situation between 800 B.C., the date of Hasanlu's destruction, and the sixth century B.C. or early Achaemenid times. We should also look for a site that will yield further evidence on Assyrian activity in western Iran, for it was principally out of the contact between Assyrian culture and the newly arrived Iranians that later Achaemenid civilization grew. This first step has already been taken. I am writing this report from Iran, where a generous leave of absence from my museum and teaching duties and a financial grant from the United States Government have put me. This year's work will be an archaeological survey by Land Rover, horse back and foot of Iranian Kurdistan.

The next step will be to conduct a major excavation at a site chosen as a result of this survey. At the moment, plans call for a four year effort with three months each summer of excavation, the whole principally supported by the ROM and under the direction of the Museum's Near Eastern Department. Whether the necessary funds for such an effort can be found remains a challenge. But then all archaeological expeditions are perhaps as much challenged by their future as they are by the past.